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Evaluation of East Wollega Coffee Germ Plasms for Coffee Berry and Coffee Leaf Rust Diseases at Haru West Ethiopia

Gabisa Giddisa
EIAR, Jimma Agricultural Research Center, P.O.Box 192 Jimma, Ethiopia

Abstract
With the objectives of developing disease resistant landrace coffee varieties and boost the yield with their intrinsic cup quality, a multidisciplinary research program have been designed and implemented at Jimma agricultural research center. Towards such over all goals, local land race development program has been implemented for East Wollega coffee producing areas. To meet this goal, local land race development program of East Wollega coffee collections were started in 2009 and 111 coffee accessions were collected and planted in 2010 at Haru research sub centre. Accordingly 111 coffee accessions were evaluated for their resistance to CBD and CLR using visual assessment and laboratory inoculation test. There were significant differences among the East Wollega coffee collections evaluated for resistance to coffee berry disease. The range was from 0% (Ew103/09) – 96.7% (Ew59/09) most of East Wollega coffee accessions show resistant reaction for CBD but some of the accessions show high susceptibility. Coffee collections were also evaluated for their resistance to coffee leaf rust under field condition at Haru research sub center. There existed highly significant difference among coffee cultivars in percent coffee leaf rust severity. Coffee leaf rust disease severity varied between 0.00% (Ew105/09) – 100% (Ew10/09).
Keywords: East Wollega Coffee Collections, Disease resistant, Colletotrichum kahawae, Hemileia vastatrix

1. Introduction

Coffee is the most important agricultural commodity upon which more than 50 countries including Ethiopia are dependent for their economy, especially foreign exchange earnings. Coffee has for centuries played an important role in the Ethiopian economy and represents the main cash crop cultivated by small-scale farmers for social, economic, political and ecological sustainability (Arega, et.al, 2008). The estimated coffee production area in Ethiopia is 561,761 ha (CSA, 2015). In Ethiopia, coffee berry disease (CBD), coffee wilt disease and coffee leaf rust (CLR) are foremost factors in reducing the quantity and quality of coffee in the country. Production of land race coffee varieties adaptable to specific agro-ecological niches allows farmers to supply high quality coffee at premium prices. Based on the extreme demand for coffee quality to the character of those origins (types): Harar, Yirgacheffee and Sidama brands are now internationally recognized and registered as property right to Ethiopia with their distinct character/flavour and taste (IPO,2008). In the past, the interest of coffee improvement program was to develop varieties that have a wider adaptation and distribute them to all coffee growing areas. It was however, lately realized that distribution of such limited varieties to all coffee growing agro-ecologies adulterate the typical quality of each specific locality or region, manifested poor adaptation and less preferred by local coffee farmers compared to their respective local cultivars.

Jimma Agricultural Research Center (JARC) was privileged in location specificity of Arabica coffee under defined agro-ecology, growing demand for land race coffee in the international market, and existence of genetic diversity in major coffee growing areas to gear our coffee research system towards specialty coffee variety development for each agro-ecological niche of the country. The development of disease resistant land race coffee varieties addressing quality issues was started at East Wollega land race coffee 5 years back in western Ethiopia. The coffee varieties were originally selected and/or collected from forest and farmers' coffee fields in semi-forest or garden production systems of East Wollega Districts and intensively evaluated and tested for their reaction to economically important diseases in the country and assessed for yield potential and quality. In this manuscript, screening of coffee berry disease (CBD) and coffee leaf rust (CLR) resistant coffee collections in East Wollega coffee producing areas of Western Ethiopia, pertaining to pathological investigations are reported.

2. Material and Methods

2.1 Description of the study area

The experiment was conducted at Haru sub center of Jimma Agricultural Research Center. The sub center is 468 km far from Addis Ababa and located at $8^0$58' N latitude and 35^0 48' E longitudes and at an altitude of 1750 meters above sea level. The mean annual rainfall of the area is 1727 mm per annum with an average maximum and minimum air temperatures of 27^0C and16^0C, respectively. The major soil type of the area is dark reddish brown, with p^H of 4.8-5.6 (Tsegaye and Taye, 2000).

2.2. Experimental Material and Design

One hundred eleven *C. arabica L.* accessions which have been collected in the year 2009 from the Dega and

Sasiga woreda of East Wellega zone and four standard checks namely: Menesibu (78/84); Haru1 (W66/98); Chala (W76/98) and Sende (W92/98) were used for the study (Table 1). The experiment was superimposed during the 2014/15 cropping seasons on six years old coffee trees.

The seedlings were field planted on July, 2009 in augmented design and mulched in immediately after planted. Each seedling was protected from direct sunlight by grass hut .The huts were removed when the dry months ends. Shade trees were planted with a spacing of 4m by 4m .Each plot consisted of ten plants in single row. Spacing between rows and plant were 2m by 2m, respectively. The plots received uniform application of fertilizer (120g DAP & 81g urea per tree) in three split and other recommended cultural practices were performed throughout the period of data collection as per EIAR/JARC coffee production manual recommendation.Coffee collections were screened for CBD and CLR reactions at Haru sub center following the standard procedures for each disease.

2.3. Testing for CBD Resistance

2.3.1. Attached berry test and disease assessment in the field

Attached berry test (ABT) was used to verify their levels of resistance by inoculating good number of growing berries on three branches (top, middle and bottom canopies) of a sample coffee tree (3-5 trees/plot) with inoculum suspension of 2 x 10^6 conidia/ml at field. These inoculated branches were covered with plastic sleeves with paper bags over night to favour infection. After three weeks, the number of healthy and CBD infected berries per branch were recorded and then percentage infected berries was calculated. Besides, visual estimation of per cent CBD infection was assessed on tree base for three years.

2.4. Testing for resistance to Coffee Leaf Rust

Six trees per accessions were considered for field CLR disease assessment using visual method. Recording was started on pick time of CLR disease appearance in the field using visual assessment methods for three consecutive years. All the data's' were finally transformed to angular values as necessary and analyzed augmented online method using SAS statistical software (SAS, 2000).

3. Results and Discussion

3.1. Testing for Coffee Berry Diseases (CBD)

There were significant differences among the Bale coffee collections evaluated for resistance to coffee berry disease (*Colletotrichum kahawae*) at Haru. In visual assessment the average severity was 56.5 percent and the range was from 0% (Ew103/09) – 96.7% (Ew59/09) some of the accessions show highest severity which is greater than 50 percent of coffee berry diseases. From these Ew52/09, Ew106/09, Ew62/09, Ew20/09, Ew85/09, Ew65/09, Ew10/09, Ew101/09, Ew9/09, and Ew109/09 which exhibited 96.7, 89.0, 82.5, 71.1, 70.0, 70.0, 65.0, 63.0, 62.5, 61.7, and 61.0 respectively.

Most of the accessions showed significantly lower disease severity (< 5%) namely, B321/07, Ew67/09, Ew16/09, Ew105/09, Ew79, Ew83/09, Ew80/09, Ew103/09, Ew51/09, Ew43/09, Ew70/09, Ew16/09, Ew8/09, Ew91/09, Ew27/09, and Ew36/09 indicating higher CBD resistance (Table 1).

There is significant variation on percent coffee leaf rust and coffee berry disease among accessions. The average CBD percent severity was ranged from 0.00 – 65.00 percent and CLR ranges from 0.00 – 100 percent (Table 15). Most coffee accessions are tolerant for coffee berry diseases but some are susceptible. Seven coffee accessions namely Ew10/09, Ew11/09, Ew19/09, Ew20/09, Ew49/09, Ew63/09 and Ew107/09 are highly susceptible for CBD showing > 25 % in field severity level. More over ten coffee collections shoe >10% CLR infection under field condition. Coffee accessions namely Ew4/09, Ew70/09, Ew71/09, Ew76/09, Ew94/09, Ew99/09, Ew105/09 and Ew110/09 exhibited resistant reaction for both CBD and CLR with less than 1 % infection (Table 1).Based on visual assessment result twenty coffee cultivars were selected for attached berry test all showed resistance reaction. There is no significant variation of attached Berry test on percent coffee berry disease among accessions (Table2)

Table1.Average Percent CLR and CBD through Visual assessment on East Wollega Collections 2016.2017 & 2018

Acces	2016		2017		2018		Acces	2016		2017		2018		Acces	2016		2017		2018	
	CLR %	CBD %	CLR %	CBD %	CLR %	CBD %		CLR %	CBD %	CLR %	CBD %	CLR %	CBD %		CLR %	CBD %	CLR %	CBD %	CLR %	CBD %
Ew 67/09	1.44	0.00	3.60	0.00	2.6	0.0	EW34/09	0.89	7.29	4.50	40.0	31.7	42.5	Ew 77/09	1.78	1.60	6.67	20.00	17.5	10.0
Ew 105/09	0.00	0.00	0.00	3.50	0.0	2.0	EW39/09	0.89	0.00	3.00	23.8	1.7	0.0	Ew 90/09	2.89	0.67	9.33	2.20	13.5	24.2
Ew 106/09	0.56	16.8	2.67	74.1	2.3	89.0	EW55/09	1.78	10.22	5.00	15.0	14.3	12.5	Ew 93/09	2.33	10.2	6.00	0.00	43.3	59.2
Ew 15/09	1.56	1.40	8.50	25.8	10.2	22.5	EW60/09	2.50	0.50	6.67	31.0	27.5	20.0	Ew 98/09	1.56	23.5	5.33	25.88	12.7	50.8
Ew 16/09	2.56	0.50	10.8	0.00	36.7	0.0	EW68/09	2.44	0.14	11.0	10.0	10.2	14.2	Ew104/09	2.67	0.00	12.5	27.67	35.8	7.5
Ew 25/09	1.67	0.00	3.00	8.00	5.8	0.0	EW71/09	0.33	0.00	4.50	8.00	20.0	7.5	EW59/09	1.22	2.00	8.33	15.00	11.2	28.8
Ew 27/09	1.78	0.33	4.00	42.5	7.8	62.5	EW72/09	4.11	1.88	2.17	26.2	23.3	50.0	Ew6/09	4.33	4.10	4.50	11.70	15.0	8.3
Ew 36/09	0.67	0.56	3.33	10.2	5.0	0.0	EW74/09	4.17	0.00	13.3	16.5	53.8	10.0	EW91/09	1.89	0.00	5.83	2.00	21.7	0.8
Ew 37/09	0.33	7.50	2.17	29.2	2.2	40.8	EW75/09	1.33	1.29	6.67	54.3	6.8	11	Ew103/09	6.39	0.00	3.33	0.00	15.0	0.0
Ew 43/09	4.06	0.13	8.33	1.57	25.8	0.8	EW89/09	2.22	1.25	10.0	12.4	35.0	0.3	Ew107/09	1.44	29.1	7.50	35.56	6.3	35.0
Ew 47/09	1.44	0.00	3.67	27.6	3.0	15.0	EW9/09	1.78	0.00	26.6	16.1	27.0	61.7	Ew11/09	12.1	33.0	7.67	32.00	4.0	45.0
Ew 51/09	3.67	1.00	12.0	15.5	20.0	0.0	EW92/09	2.44	6.25	8.33	55.5	20.0	54.2	Ew19/09	4.00	33.0	1.00	48.10	13.3	35.0
Ew 52/09	0.89	25.0	3.67	87.8	2.8	96.7	EW95/09	0.44	5.00	9.17	38.0	26.7	20.8	Ew20/09	10.2	52.8	21.6	71.11	8.7	63.3
Ew 66/09	1.00	6.00	4.33	61.0	3.7	39.2	EW96/09	2.44	0.00	5.33	0.38	11.8	0.0	Ew33/09	2.22	7.20	1.50	27.00	31.7	22.5
Ew 70/09	0.67	0.00	5.17	3.38	1.5	0.8	EW99/09	1.11	0.00	2.33	5.00	23.0	0.0	Ew58/09	8.00	18.1	1.33	26.57	35.0	19.3
Ew 76/09	0.67	0.00	8.33	2.43	6.8	0.0	Ew10/09	2.89	65.00	8.33	0.00	9.2	10.0	Ew63/09	1.22	27.2	9.17	52.78	15.8	32.5
Ew 79/09	1.22	0.00	0.80	20.0	0.8	0.0	Ew108/09	15.00	11.22	1.33	2.43	39.2	29.2	Ew69/09	3.00	0.67	1.00	2.86	9.3	12.5
Ew 8/09	2.89	0.30	6.83	0.00	18.3	0.0	Ew109/09	12.22	1.63	8.33	61.0	12.0	40.0	Ew80/09	8.56	0.14	0.83	0.00	34.2	0.4
Ew 82/09	1.22	3.50	3.00	21.3	3.0	0.0	Ew111/09	6.22	0.60	20.0	9.80	40.0	0.8	Ew83/09	8.67	0.00	0.00	0.00	56.7	1.7
Ew 85/09	1.22	2.78	2.33	70.0	3.0	25.0	Ew 13/09	14.00	1.60	2.33	0.00	35.0	2.5	Ew84/09	8.78	1.83	2.83	27.50	23.3	25.0
Ew 88/09	0.83	1.60	7.50	25.0	3.7	23.3	Ew 14/09	11.11	0.50	7.50	0.00	37.0	25.0	Ew86/09	6.89	2.50	11.6	4.00	38.8	16.7
Ew 94/09	0.56	0.00	2.75	0.01	9.3	32.5	Ew 2/09	3.33	14.17	9.17	0.01	16.0	43.3	Ew87/09	11.8	2.33	8.00	4.45	55.8	27.5
Ew5/09	4.67	8.75	3.50	45.0	5.8	25.0	Ew 23/09	10.44	0.22	5.83	74.1	35.0	0.0	Haru 1	3.39	0.13	**9.41**	**19.2**	2.96	2.4
Ew 101/09	2.67	0.00	0.60	10.2	15.8	63.0	Ew 26/09	12.78	2.20	11.6	0.0	38.3	17.5	Chala	1.75	0.00	**8.4**	**9.7**	3.98	0.16
Ew 110/09	3.00	0.00	4.33	22.8	8.7	15.8	Ew 32/09	4.56	12.50	20.8	10.2	45.0	45.0	Sende	3.50	0.21	**10.1**	**8.31**	31.7	7.24
Ew 4/09	0.67	0.00	12.5	35.6	11.7	11.8	Ew 40/09	4.67	17.80	9.17	3.38	29.2	50.8	Manesibu	3.72	0.00	**9.8**	**8.2**	28.4	0.1
Ew 73/09	3.56	2.50	15.0	8.33	32.5	0.0	Ew 42/09	5.56	0.00	9.17	3.50	55.8	0.0	**Mean**	**5.84**	**5.80**	**3.01**	**4.6**	**2.5**	**13**
EW18/09	0.56	2.00	2.33	10.8	39.2	57	Ew 57/09	8.78	0.00	12.5	21.3	62.2		**LSD (0.5)**	**3.72**	**1.68**	**1.7**	**6.96**	**2.00**	**9**
EW24/09	2.67	1.25	6.67	40.8	26.7	64.0	Ew 62/09	9.78	10.20	6.83	1.57	3.0	82.5	**CV(%)**	**27**	**13**	**53**	**40.6**	**11**	**26**
EW31/09	2.00	3.88	5.83	23.3	29.2	19.2	Ew 65/09	8.78	5.00	25.0	70	37.5	47.5							

Table 2. Average Percent CBD through Attach Berry Test on East Wollega Collections 2017

Accession	CLR			CBD			
	2015	2016	2017	2015	2016	2017	ABT %
Ew 70/09	0.67	5.20	1.50	3.40	0.00	0.83	1.41
Ew 8/09	2.89	6.80	18.30	0.00	0.30	0.00	0.10
Ew 67/09	1.44	3.60	2.60	0.00	0.00	0.00	0.00
Ew 105/09	0.00	0.00	0.00	3.50	0.00	2.00	1.83
Ew 36/09	0.67	3.30	5.00	10.20	0.60	0.00	3.60
Ew 16/09	2.56	10.80	36.70	0.00	0.50	0.02	0.17
Ew 43/09	4.06	8.30	25.80	1.60	0.10	0.83	0.84
Ew 25/09	1.67	3.00	5.80	8.00	0.00	0.00	2.67
Ew 29/09	2.22	5.30	7.50	12.40	0.00	0.00	4.13
Ew 73/09	3.56	15.00	32.50	8.30	2.50	0.00	3.60
Ew 96/09	2.44	5.30	11.80	0.40	0.00	0.00	0.13
Ew 91/09	1.89	5.80	21.70	2.00	0.00	0.83	0.94
Ew 42/09	5.56	9.20	55.80	3.50	0.00	0.83	1.44
Ew 21/09	5.00	6.80	14.30	0.00	1.80	2.52	1.44
Ew 12/09	6.44	9.20	25.00	5.10	0.00	0.00	1.70
Ew 30/09	8.00	6.00	17.50	5.00	0.00	9.33	4.78
Ew 45/09	9.00	3.70	49.20	1.30	0.00	0.00	0.43
Ew 80/09	8.56	0.80	34.20	0.00	0.10	0.40	0.17
EW103/09	5.23	3.30	15.00	0.00	0.00	0.00	0.00
Ew 6/09	4.33	4.50	15.00	11.70	4.10	8.33	8.04
						Mean	**4.31**
						LSD	**ns**
						CV %	**11.00**

3.2. Testing for Coffee Leaf Rust (CLR)

Three years East Wollega coffee collections were evaluated for their resistance to coffee leaf rust under field condition at Haru sub- Center. There was significant variation on percent coffee leaf rust among coffee cultivars in percent coffee leaf rust severity (Table 1). Coffee leaf rust disease severity varied between 0.00% (Ew105/09) – 100% (Ew10/09).

Accessions Ew10/09, Ew83/09, Ew87/09, Ew74/09, Ew32/09, Ew111/09, Ew108/09, Ew18/09, Ew38/09, Ew14/09, Ew16/09, Ew104/09, Ew58/09, Ew23/09 and Ew89/09 showing susceptible reaction (>35 %) with CLR severity value of 100, 56.7, 55.8, 53.8, 40.0, 39.2, 39.2, 38.8 and 38.3 % respectively. Coffee cultivar Ew34/09, Ew60/09, Ew9/09, Ew43/09, Ew72/09, Ew99/09, Ew92/09, Ew51/09, Ew71/09, Ew8/09, Ew77/09, Ew2/09, Ew101/09, Ew55/09, Ew90/09, EW19/09, Ew98/09, Ew109/09, Ew59/09, shows moderately resistant

reaction (<30%) i.e. 27.5, 27.0, 25.8, 23.3, 23.0, 20.0, 20.0, 20.0, 17.5, 13.5, 13.3, 12.0 and 11.2% coffee leaf rust severity (Table 1). Coffee cultivars Ew105/09, Ew5/09, Ew39/09, Ew37/09, Ew106/09, Ew47/09, Ew88/09, Ew36/09, Ew107/09, Ew69/09 and Ew94/09 exhibited resistant reaction (<10 %) with CLR severity value of 9.3, 9.3, 6.3, 5.0, 3.7, 3.0, 2.3, 1.7 and 1.2 % respectively. However, very few accessions show highly resistant reaction namely Ew105 and Ew79/09 exhibited 0.00 and 0.8 % (Table 1).

4. Summary and Conclusion

Ethiopia is the centre of origin and diversity of Arabica coffee. The country is ecologically very diverse and coffees grown under these environments are different in quality, disease resistance, yield potential and many other traits. A new breeding strategy, known as '*Local Coffee Landrace variety Development Program*', was designed with main objective to develop high yielding and disease resistant cultivars with good quality for the major coffee growing areas of Ethiopia (Bayetta and Labousie, 2006). Local land race variety development program of East Wollega coffee collections were started in 2009 and 111 coffee accessions were collected from the Dega and Sasiga woreda of East Wollega zone in 2009 and planted in 2010 at Haru research sub centre. Accordingly 111 coffee accessions were evaluated for their resistance to Coffee Berry Disease Coffee and Coffee leaf Rust using visual assessment and laboratory inoculation method.

There were significant differences among the East Wollega coffee collections evaluated for resistance to coffee berry disease (*Colletotrichum kahawae*) at Haru. In visual assessment the average severity was 56.5 percent and the range was from 0% (Ew103/09) – 96.7% (Ew59/09) some of the accessions show highest severity which is greater than 50 percent of coffee berry diseases. Three years East Wollega coffee collections were evaluated for their resistance to coffee leaf rust under field condition at Haru research sub center. There existed highly significant difference among coffee cultivars in percent coffee leaf rust severity (Table 1). Coffee leaf rust disease severity varied between 0.00% (Ew105/09) – 100% (Ew10/09). There is no significant difference among East Wollega coffee cultivars in percent of attached berry test (Table 2). Based on over all detailed analysis of Visual assessment and attached berry test investigation some of East Wollega coffee accessions are promising for release pretending that they have other required traits like yield and good cup quality.

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